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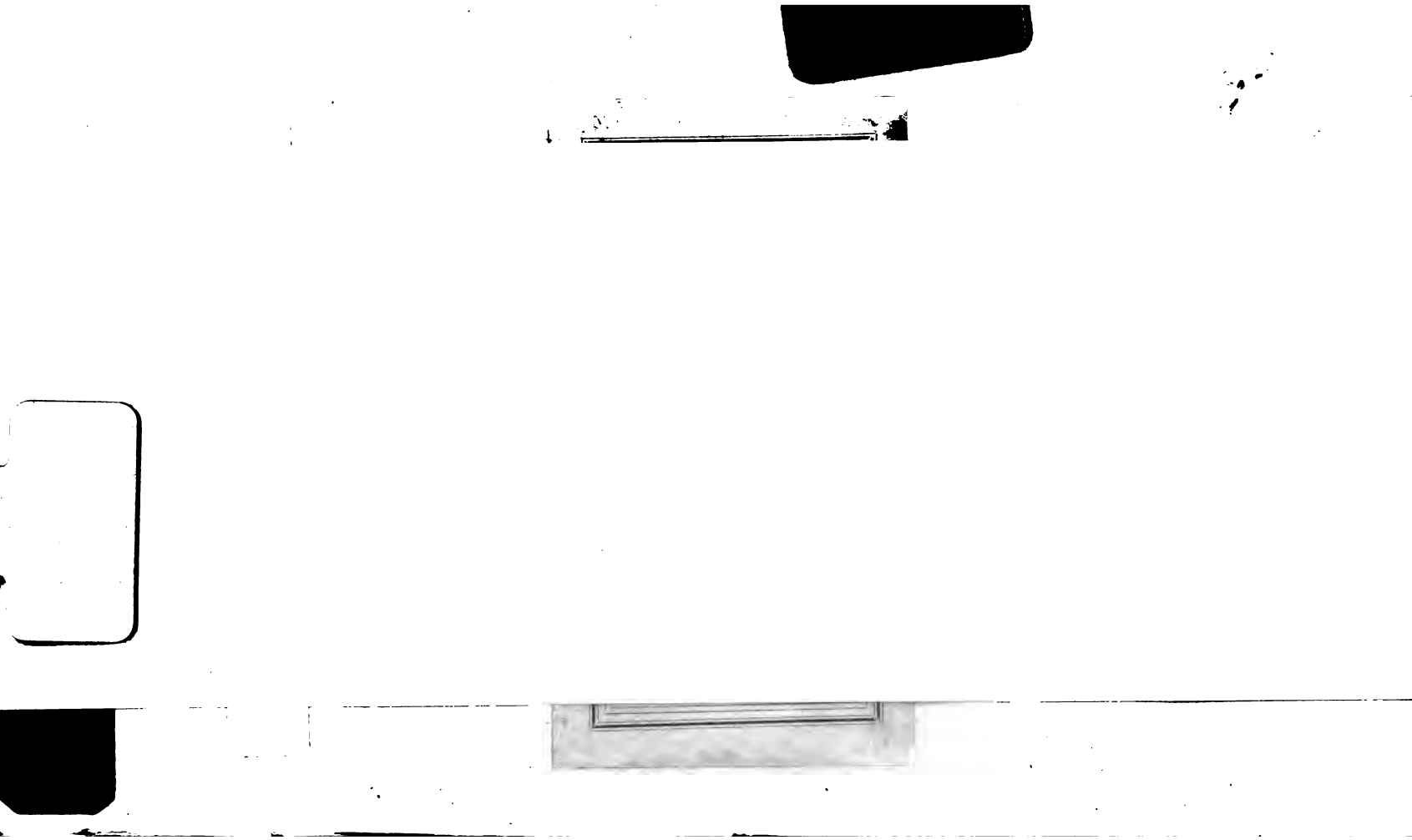

RURAL HYDRAULICS

A PRACTICAL TREATISE

ON RURAL HOUSEHOLD WATER SUPPLY.

GIVING A FULL DESCRIPTION OF SPRINGS AND WELLS, OF PUMPS AND HYDRAULIC RAM, WITH INSTRUCTIONS IN CISTERN BUILDING, LAYING OF PIPES, &c.

BY

W. W. GRIER.

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PREFACE.

Having for years sought a practical work on rural hydraulics without success, and in the meantime experimenting largely on the subject, and gaining by experience and cost, many points of value, I have concluded to give my gleanings to the rural world at a trifling cost, and in a homely way.

Technical terms have been studiously avoided, and the plainest and most pointed terms at my command used. If I can add my mite to the store of knowledge, and aid in helping my fellow farmer and toiler to an additional home comfort, I shall have accomplished my purpose

INTRODUCTION.

The subject of Hydraulics has ever been one of interest to the human mind, and for ages commanded the attention of the learned and enterprising. From the time of Rebecca at the well, to the Centennial of American independence, the crowning year of mechanical perfection, the practical application of machinery to elevate water for use or for ornament, has been the study of earth's noble benefactor—the inventor.

First, the simplest of hydraulic machinery, the earthen vessel; then the attachment of a rope or pole, letting the vessel into the well; next the wheel, with an ascending and descending series of buckets; again the use of a treadle; then of oxen; then water to elevate water by wheels; the Hydraulic Ram; then wind; and last, but perhaps the most popular, steam.

It may well be said that we can judge of the civilization of a country by consulting the perfection of its practical hydraulics.

ANCIENT WATER WORKS.

When Babylon was at the zenith of its glory its hanging gardens 350 feet high were copiously watered by wonderful machinery, raising the water step by step from the river Euphrates. Like many of the arts of the Ancients the means or machinery by which such wonderful results were attained has passed with that strange but intelligent people into the shades of forgetfulness. Not a sketch, a drawing or a trace of that device has been handed down to us.

The power devices of the Ancients were very crude but as in the case of Babylon were very efficient. The want of pipes of sufficient strength to carry such heavy pressure must have opperated very seriously in their hydraulic engineering. We who live in an age of Iron and Steel cannot appreciate the difficulties of engineering encountered by the Ancients when as at Herculaneum the hammers were made of gold, because of its abundance, and tipped with iron, because of its scarcity and value.

THE ORIGIN OF WATER IN THE EARTH.

Nearly all the water above the sea level is elevated by the agency of the Sun, whose heat evaporates the surface water. The air being dry and warm absorbs the vapor thus forming clouds which are wafted over the land becoming under favorable circumstances condensed into fine drops or globules which unite forming rain drops, or still farther, snow and hail which by their reduced bulk and increased specific gravity fall to and sink into the earth, filter through the porous earths and sand till reaching a stratum of clay or rock impervious to it, flows pown to its greatest depression and issues in hilly countries as a spring or in flat or low countries in a subterranean basin.

The action of the sun on the water seems slow and insignificant, but its results are mighty, its work silent and surely done, and earth otherwise arid and parched, is made to bud and blossom as the rose, and form for man a beautiful, fruitful, and verdant home.

Man with his limited understanding, cannot comprehend in their true proportions, the wonderful aerial visions, which become so common from frequent association that they lose all novelty, and cease to elicit a word of comment or even to attract attention. The glorious sun-set or sun-rise, gilding the heavens with its thousand hued rainbows, and spreading daily before us such a varied and wondrous display of colors and grandeur, is unheeded, and the part they perform in the economy of nature and the service of man, cost him, at most, but a casual thought.

CAUSE OF SPRINGS.

The water, from rain, filtering through the various strata, composed of such varied minerals; is more or less charged with and carries in solution, lime, salt, sulphur, magnesia, etc. These substances give it character. Springs most prized flow from granite, freestone, or sandstone rock, which either does not possess or give off in solution their peculiar constituent elements.

MEDICINAL SPRINGS.

Other springs highly prized for their medicinal properties carrying in solution, iron, sulphur, salt, lime, chalybeate, and other combinations, are highly prized for their medicinal and health restoring properties. Institutions such as the Sanitarium of Clifton springs, N. Y., are built up on the supposed or real merits of the healing efficacy of their springs containing, sulphur, iron and such other combinations as are admitted to be sovereign remedies.

HOT SPRINGS.

Springs which do not depend on the rain for supply are very rare but occur in certain districts far separated, such are the hot springs of Arkansas, the hot (mud bath) springs of California, and the noted Geysers of Iceland, which discharge from a subterranean source.

ARTESIAN WELLS.

Artesian wells, or springs rather, (man having only made an outlet for them,) have been made in various countries of the earth and in some cases eject large quantities of water, oil, or gas.

WELLS.

Having briefly referred to the origin of springs we now come to the description of the best means of utilizing them, beginning with the spring and the means of securing a body of water near where it issues. When a spring issues on the surface the means of controlling it is a comparatively easy matter, but as in many localities no springs appear on the surface, water must be sought by digging, as a good supply of water can usually be found in from 10 to 100 feet of the surface, either by sinking to a fissure through which a spring is flowing or by reaching a subterranean lake or basin. In localities where the sub stratum is composed of gravel, water will be found at a uniform depth but where the stratum is of rock or clay no uniformity of depth prevails. And reaching water in many cases depends entirely on striking a fissure. Selecting the spot for sinking a well is therefore of great importance but as yet little light has been thrown on the subject by science. The topography of the land may give some indication of fissures in the sub-stratum, but is not of much practical value. We may have selected a site for a well just over a solid rock hundreds of feet deep, through which there is no fissure, and as a consequence though water may surround that rock to near its surface the well will remain dry, which is abundantly proved by the experienced of those drilling for oil. Many wells producing little or no oil till by the use of nitro glycerine, a blast is made at the bottom of the well hundreds of feet deep, which breaking the rock into which the well was drilled, allows the oil to flow into the well. A few years since on property of Mr. Jas. Irons, in Beaver Co., Pa. a well was dug through rock to a depth of perhaps 30 ft. without striking water. At one time as Mr. Irons was ascending the well he heard running water, by the aid of a drill he made an opening a few inches deep, striking a fine spring, which soon filled the well to that depth.

SEARCH FOR WATER.

For ages the search for water has been attended by many superstitious forms and even yet there are some intelligent persons who think in the hands of certain favored ones, the peach or hazel twig points with unerring certainly to the living stream.

In this country that fallacy lingers only in the minds of a few who have not given the matter a thorough investigation.

WELL DIGGING.

The mode of sinking a common well is so familiar to all as to scarcely need a line. After digging a hole 5 or 6 feet in diameter, as deep as the earth can be conveniently thrown from, a windlass made of a timber 5 feet long and 5 inches in diameter having a crank on one or both ends, is placed on standars 3 feet high, firmly braced to a platform made of plank leaving an opening about 4 feet square. A rope having a tub attached to one end is coiled around the shaft and with the addition of pick, shovel, drill, powder and fuse the machinery is complete, and manned by two or three men the laborious, dangerous and uncertain work begins. When there is danger of the earth caving, a crib is inserted, made 8 feet in length, where there is much danger, or in 16 feet lengths, where the material is more firm, two sections cut like wagon fellows only 4 or 5 inches broad, are nailed together and a circle so made is placed at each end, and in long cribs one is placed in the middle, to which on the out side narrow boards are nailed, this is then inserted in th opening aud as the well is dug the crib descends until another section of crib is required and so on till solid material is reached. The crib should never be lowered into the water as the wood imparts a bad taste to it. A sufficient depth of water being secured a wall should be built (perferable) of hard brick or stone (using no mortar) begining at the bottom of well, if no rock was found in digging, leaving the crib in, in most cases. There should be projections of some durable wood, or pieces of $\frac{3}{4}$ in. galvanized gas pipe built in the wall about 3 feet apart, forming a ladder to facilitate entering for inspection and cleaning. The upper five or six feet should be built very close and tight to the bank, to prevent surface water and vermin entering, and a stout frame provided with close trap door.

WATER ELEVATORS.

Among the practical appliances for raising water now, we have the many forms of pump driven by any of the known

powers of water, wind and steam, some of which are only available for extensive establishments.

Most of the pumps are built on the suction or air pressure principle, and some are built both as suction and lift or force pumps. The suction pump depends on the principle of pneumatics, that the presure of the atmosphere is equal to a column of water 33 feet high, or of mercury 33 inches, consequently if the air is exhausted from a pipe (whose base is in water,) the water will rise to that point and no higher, but from imperfection in construction the practical point is not over 20 or 25 ft., and as a rule the nearer the pump to the water the better the results. The power required is the same, be the water lifted or forced. Pumps are made of wood or iron, the wooden pump made of cucumber wood have the preference over others, as they impart but little taste to the water. The newer styles of pump barrel made of metal and porcelain or brass lined are very superior to the older ones, and deep well pumps having the cylinder located at any depth wished, have the preference. Power pumps have been developed to a wonderful extent of late years, and great perfection has been attained. Among the most novel is the Pulsometer, the working parts are exceedingly simple, and of such construction that very muddy thick fluids may be driven through them without injuring them. Of the various powers for elevating water, steam for extensive establishments is most used. Nearly all the pumps of city waterworks are driven by steam, it being considered the most economical and easiest controlled. But for private use wind and water are the chief motors, wind where the country is level, the winds being more powerful, and constant and springs more rare. There are a number of improvements of late years, whereby wind mills are made self-regulating, closing by a governor as the wind increases in velocity and opening again as the wind moderates. The chief objections raised to wind power is in many places its uncertainty and the freezing of the working parts whereby disarranging its automatic machinery, but by recent improvements great simplicity of construction is attained. The Farm Wind-Mill is from 8 to 14 feet in diameter and costs from $90.00 to $200.00.

Water is comparatively little used to elevate water, though at Fairmont waterworks, Philadelphia, it is used on a large scale. The turbine wheel by recent improvement has been so constructed and improved that in some localities it gives very satisfactory results. But among hydraulic machines for practical rural use none occupies such a prominent position as the Hydraulic Ram, which was said by Eubank, to be the neatest hydraulic machine known.

The Hydraulic Ram was the invention of Montgolfier, a French paper manufacturer, in 1796,(80 years since) who some 14 years previously had in connection with his brother, invented the balloon.

"Whitehurst, a watch maker of Derby, England, had in 1772, applied the same principle, and was probably the first who had raised water by a ram designed for that purpose, but it was very imperfect and required the assistance of man to operate it. Although on the same principle, Montgolfier's invention is believed to be entirely inpependent of Whitehurst. But if it were even admitted that Montgolfier had been acquainted with what Whitehurst had done, still he has by his improvement made the Ram entirely his own. He found it a comparatively useless device and by the introduction of a self-acting valve, rendered it one of the most efficient. It was neglected or forgotten and he not only revived it, but gave it a permanent and prominent place among hydraulic machines, and actually made it the most interesting of them all. Since the time of Montgolfier improvements only in the detail of manufacture have been made. He left it in itself an almost perfect machine. It required only a sentinel to watch with untiring vigilance, and, in case of stoppage, either from lack of water, obstructions, or careless adjustment, compel it to automatic action. The sentinel imparts to it as it were a principle of life and intelligence. And now it holds undoubtedly the proud position of being the most complete and simple hydraulic machine known." and is probably as near perpetual motion as man will attain.

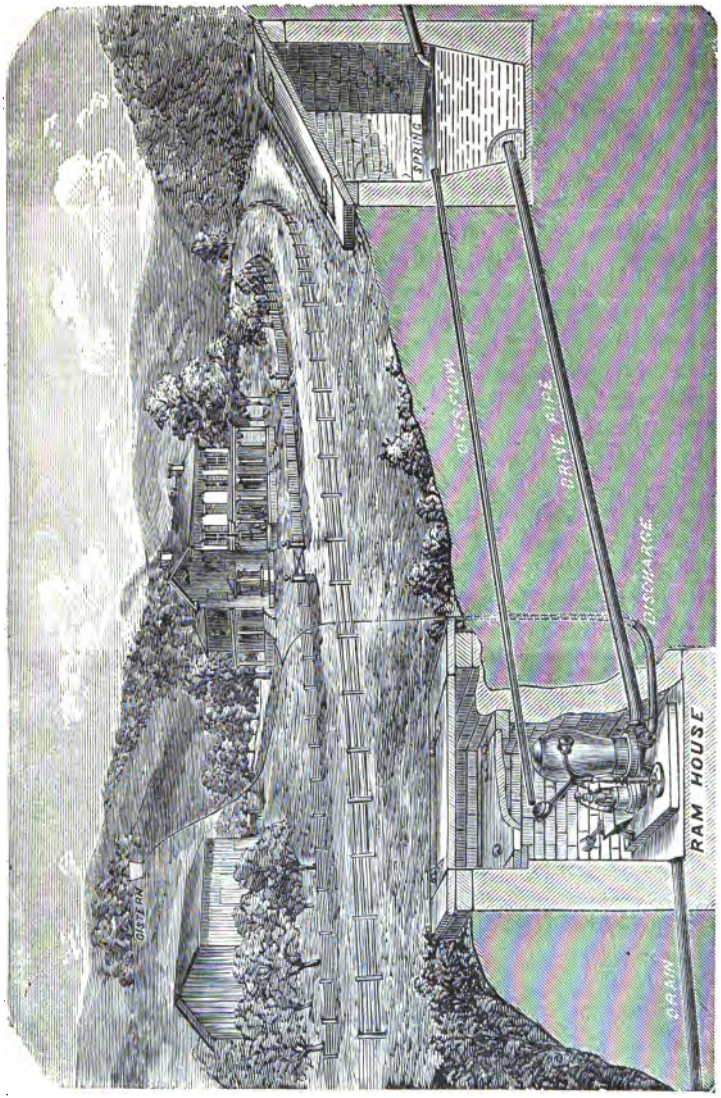
As long as an abundant and pure supply of water is furnished, the ram works with but little attention. But if sand, chips, or air by any means enter the drive pipe, it is liable to stop at any moment, and once stopped, without an automatic power to start again, would remain idle and useless till started by man.

Usually springs are found in valleys and rugged places, and below the level of the house which is mostly placed on an elevated spot. In such a position we place the ram, and after years of trial in some cases it has been abandoned on account of stopping so frequently, and being so inaccessible. But from recent simple improvements it has become a self-acting, cheap, durable, and efficient water elevator requiring little or no attention.

DESCRIPTION OF HYDRAULIC RAM.

The principle involved in the Hydraulic ram is simply one of the lever. The water in the drive pipe is the power, the

PLATE 1.



Cut showing premises supplied with water by Hydraulic Ram, and the respective locations of Spring, Ram House and Cistern.

valve is the fulcrum, and the water raised is the weight. In other words it is as if one barrel of water was hung on a lever 35 feet from the fulcrum, and 7 barrels of water was hung on the short end of lever 5 feet from the fulcrum, which would be an exact balance, but to raise the one barrel we must give a few gallons as an over balance, as the 7 barrels descend 5 feet the one barrel is elevated 35 feet.

The mechanical appliance to reach that result is the hydraulic ram and is constructed in the following manner.

CONSTRUCTION OF RAM.

A base having four projections or feet on the lower part by which it is screwed firmly to the plank, on which it should rest, and its upper surface fitted for the air vessel and valves which are attached to it by bolts. Through it holes are cored properly made for attaching the drive pipe at one end and the main valve at the other, having inlet and outlet holes, from the air vessel. To the outlet a discharge pipe is attached. The ram, proper, is made of cast iron, the impetus valve and seat of brass, and the air vessel valve of leather. The air vessel is generally made of cast iron, secured by bolts to base. Glass has been but little used, but promises to come into more general use, since the great improvement made in attaching it by a screw on the outside of the air vessel, similar to fruit jars, which makes it strong and easily fastened. The great advantage of a glass air vessel being that the height of water in the air vessel and its action at every stroke of the valve can be clearly seen at all times, and an assurance given that there is sufficient air to form a perfect cushion. It is often the case that a ram throws very little water, simply because the air vessel is filled, or nearly filled with water. The cost is but little over the cost of cast iron, and has many advantages.

The drive pipe for No. 4 ram should be about 50 feet long and 1¼ in. in diameter, for data of exact length and diameter, see the accompaning table. this pipe should run in a direct line of descent from spring to ram, having from 18 in. to 10 or 15 feet of fall. The valve being closed, the water in drive pipe is at rest. Push it down and 1 to 3 lbs. of water immediately rush out and is lost, by which time the water in the drive pipe has attained considerable velocity, carrying the impetus valve up and closing it, and the full weight of water, 15 to 20 lbs., strikes a solid blow against the valve and crowds in all directions, seeking an outlet which it finds through the valve opening into the air vessel, (the air being a spring or cushion to relieve the stroke,) and driving 1-7 of the whole volume in a continuous stream, to an elevation of 30 to 150 feet, ac-

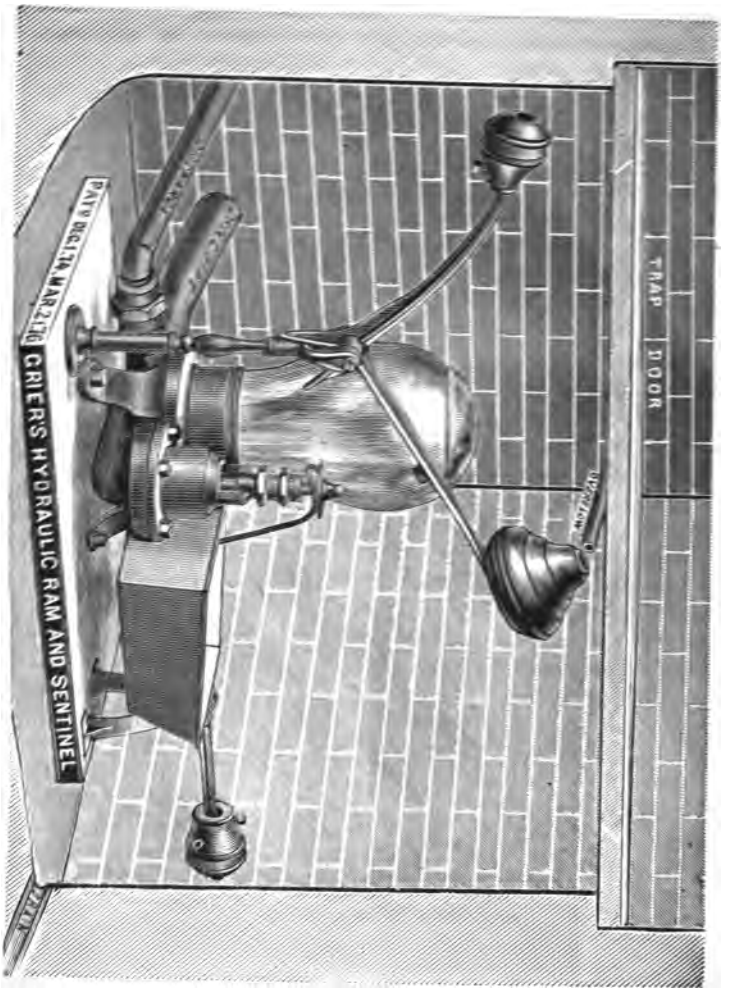
cording to the fall from the spring to ram. Immediately as an equilibrium is reached the air vessel valve closes, a slight reaction takes place, a partial vacuum is formed, the impetus valve drops, the water again rushes out, carries the impetus valve up with like results, and so it may run for weeks without attention but is liable at any moment to stop closed, either from too much air in the pipes, or too little in the air vessel, breaking the reaction, or from a grain of sand or chip. In fact the ram is very capricious and often puzzels the most expert.

SENTINEL.

Here it is that the "Sentinel" proves its great value for as soon as the impetus valve has closed from any cause, the sentinel stands prepared to strike a blow, and will continue striking till the valve operates. The sentinels are essentially of the same construction, each having a hub and two spokes. On the end of one spoke is an adjustable weight, on the other a can having an adjustable opening. The hub is supported by a stand screwed to the planks on which the ram rests. The lower sentinel is kept out of use as long as the ram is working by the splash from the impetus valve, but as soon as that valve stops down, the water ceases to fall into the can, and gently ripples out of one over the valve seat. As the water in the can escapes, it becomes lighter, rises and carries the impetus velve up, closing it. As no water can now escape, the spring basin fills and overflowing the stream, falls into can of upper sentinel, part of which passing through it to the lower can, removing it out of the way of the valve. The can of the upper sentinel filling at the same time, it descends and striking the top of valve stem, puts it in motion. As the can descends it moves from under the overflow stream. It soon becomes empty and lighter and rises to its former position, and if the impetus valve does not operate, it descends again and again till it does operate. This sentinel differs from all other devices for keeping the ram in motion, in that it keeps striking until the valve does operate, all other devices have but a single movement, and if the valve does not open with that, they are of no further service until operated by man. The standards and arms of sentinel are made of malleable iron. C plated.—The cans and bolts are of brass, and will last for years. Price of sentinel complete with 3 ft. of pipe, $10 00.

The value of the hydraulic ram to the world is greatly enhanced by this improvement, as it is now a complete automatic pump furnishing its own power, and seldom requiring attention.

PLATE 2.



Numberless questions are asked by those wishing the comforts and pleasure afforded by abundant water supply, which I shall endeavor to answer pointedly.

First, as to spring. Is it of sufficient capacity by the use of a ram to answer my requirments? A very small stream, if properly utilized, will, in most cases, supply an ordinary family, throwing the water 30 to 60 feet high. A spring yielding but one gallon per minute is very small, and is not quoted by manufacturers as practicable for use of ram, as the friction is so great. No ram smaller than No. 2 is used at present, and Nos. 3 and 4 gives proportionately much better results, but by the use of the "sentinel" Nos. 3 and 4 can be used, as a head of water is collected at the spring and a full stream is used till all is gone, when sentinel No. 2 closes the valve to collect another supply. A spring furnishing 1 gallon per minute with fall of 5 feet from spring to ram, will discharge from 150 to 200 gallons of water per day at an elevation of 35 feet. It is generally conceded that a fall of 18 inches will give satisfactory results; but I know, from long experience, that four feet is a very satisfactory fall to raise water 30 or 40 feet, and where a fall can be had and all the water the ram can raise is required, a fall of 10 or 15 feet or even more may be made, the drive pipe should be from 30 to 50 feet long. The question of fall from spring may be readily answered by using a common level, and sighting to a point 50 to 70 feet down the stream or even a 100 feet, from which point to the spot selected for the ram, a drain may be dug with just sufficient fall to carry off the waste water from the ram. By this means the ram may be placed several feet underground and both ram and pipes be effectually protected from frost, as they should be in all cases.

The snift valve is a very small hole made in the drive pipe near the air vessel; its use is to supply the air vessel with air, as it is absorbed by the water continually passing through it. When the main valve in the ram has been driven up a reaction takes place and a small amount of air is drawn in. Immediately the water in drive pipe moves down carrying this globule of air, which at the next stroke of the ram is thrown into the air vessel, keeping it replenished. The hole should be very small, if only the size of the point of the finest needle the better. It is found that a $\frac{3}{8}$ or $\frac{1}{2}$ inch hole being bored in the pipe near the ram and preferaby on the side of the pipe, and a thread cut in it fitted with a square headed nut, through which from the inside a hole has been bored, making a very fine opening is the best way toconstruct it. If the hole becomes too large, it will be injurious to the action of the ram, then some soft metal can be put in and bored out again finer.

COST OF RAM AND PIPES.

The approximate cost of ram, cistern pipes, etc., is about as follows, but will vary with location.

A ram No. 2, with sentinel and glass air vessel when desired,	$20.00
" " 3, " " " "	25.00
" " 4, " " " "	30.00
" " 5, " " " "	35.00
" " 6, " " " "	50.00
Drive pipe, fifty feet.	10.00
300 feet discharge pipe ¾ galvanized or enameled.	30.00
Spring basin, 6x4 feet.	20.00
Cistern averaging 8x10. " "	25.00

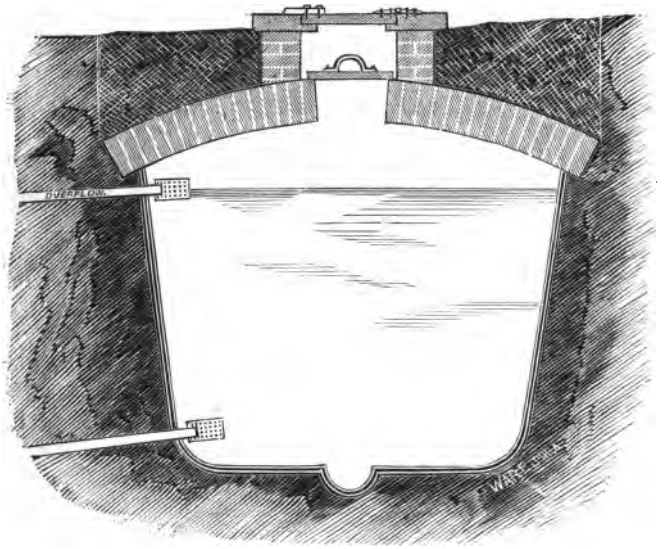
If there is not an elevation near, a cistern of from 150 to 200 gallons in attic will answer having the discharge enter it near the bottom, and an overflow pipe an inch or two from the top, (see diagram) cost $10. 00 Total for ordinary distance, and elevation, from, $100. to $150.

This work is intended as a practical hand-book for the farmer or business man, living in the country, and supplies a want long felt, by which a person of limited means, and without practical knowledge of hydraulics, as applied to farm or rural economy, might, on its perusal determine on the feasibility of supplying his premises with water, and the best means for so doing. The best and most satisfactory supply is from at an elevation higher than the point at which it is wanted, as the intervention of machinery is always objectionable, when it can be dispensed with. The only question in this case is the cost of cistern, and digging; and the knowledge of the building of a cistern and the kind and calibre of pipes to use.

DIGGING FOR CISTERN.

Having selected the spring and determined on the manner of using it, we should dig into the hill 6 to 10 feet to get beyond the reach of frost, and be more secure against rains, flooding muddy surface water into it, and also, if possible, to concentrate the streams, as in many cases springs seem on the surface to be a mere marsh, but further in, issues as a single strong stream. The streams having been gathered in one should be carried in a temporary pipe beyond the outer edge of cistern, and conducted to one side of the line where the digging for pipes is to be done. We will assume for convenience that the cistern is to be 10 feet in diameter at top, 8 at the bottom and 8 feet deep, which would hold 120 barrels of water. Then lay out cistern by driving a stake in center, take a string six feet long, describing a circle (diameter 12 feet) remove the earth to a depth of 14 inches, edges plumb, driving the stake

PLATE 3.



'Cut of Cistern.

in as you proceed, the more readily to keep the center, dig 9 in. farther, giving such a slope as shown in cut 3, against which the first course of arch brick is to be laid. Then use the string describing a circle of ten feet, and taper the walls about as in cut 3, to the desired depth. In loamy soil about the angle given in cut 3; in stiff clay nearly vertical; in sandy soil more sloping. If the earth dug through is disposed to slip, a lining of brick 4 inches thick should be laid in cement. Usually the brick lining is unnecessary, for if one coat of cement can be put on well, there will be no danger of caving in.

Should a small spring be tapped in digging for a cistern, a vertical trench from it to bottom of cistern, deep enough to lay a brick on end, (leaving a small trench back of it for the water to trickle down,) should be laid, after the cement hardens; this opening may be closed permanently.

TRENCH.

Beginning at the lower end of trench for pipe dig the trench 30 to 40 inches deep, (having if possible a continuous grade) to within two feet of cistern, and at least as low as the bottom of cistern, then take a quarryman's drill, or pointed iron, and dig a horizontal hole through to cistern, which may enter the cistern a few inches above the bottom. The pipe may now be inserted, the earth tamped solid along the whole line, so as to leave the pipe undisturbed after the cement is applied to cistern. The object in digging a hole horizontal through which to put the outlet pipe, is that the earth may be left solid against which to cement. The cistern at spring need not be so large as the one described, where a hydraulic ram is to be placed below it, as the drive pipe of a hydraulic ram should have a continuous fall from spring to ram, and to use all the water must enter near bottom of cistern, arrange the inlet pipe from spring a trifle up in the arch, and the overflow pipe an inch or so below the arch, having its inner end curved down about an inch.

CEMENTING CISTERN.

Having the cement in readiness, apply the coarser coating to the earthen wall; first seeing that the wall is moist, at least so a bond may be made between the earth and the cement; begining at the bottom of cistern and working up, putting on a coat one or two inches thickness. As soon as it has thoroughly set, which should be in two or three hours at most, apply another coat richer in cement, $\frac{3}{4}$ to 1 inch in thickness, which on properly setting should be followed by a third coat of pure

cement (if procurable, Portland), perhaps ¼ in. thick, when this last coat has become hard, another coat of cement applied with a whitewash brush may be put on, as that will fill any pores that might possibly remain. The floor should have a covering, too, to make it as solid as the walls, and should have a dish shaped floor, to more readily collect the water and sand when cleaning out.

ARCH.

The arch is best made by laying hard brick on end, using cement, or as is done in many cases, using only rich lime mortar, laying the brick each one slanting (so as to point to an imaginary center 8 or 10 feet from the surface) in complete circles, each course gradually rising as in the plate forming the arch. On first thought it would seem to the inexperienced that the brick would fall in, but the cement, mortar, or even common stiff clay, with which arches are frequently built, is sufficient to hold each brick in place till the circle is complete, forming a complete arch in itself. As each course is completed, cover it with a coat of cement, and over this spread earth, on which boards should be laid to prevent treading on any single brick, while laying the remaining courses. Other circles are laid converging toward the center, where an opening only a little larger than a barrel is left. Procure a barrel (a flour barrel will answer the purpose), bore a hole in center of the bottom of barrel, insert a pole reaching to bottom of cistern, which will allow the barrel to go only about ⅓ through the arch. The barrel is then braced from three or four points, by leaning brick from the arch to it, and then completing the arch up to the barrel with brick well laid in cement or mortar. Some persons build a frame work or crib on which to place the brick and hold them till all is finished. Such is not necessary for brick, but is for stone; unless the arch is made very high in the center, after the cement around the barrel has hardened, break and remove the barrel, then enter cistern, cement the inside of arch thoroughly, connect the spring permanently with the cistern. Build a wall around the hole, inserting four bolts well painted, which will reach high enough to screw the trapdoor frame into, (preferably square) and a few inches larger, 12 or 15 inches high, up to which the earth may now be graded. A lid should be laid on the brick arch, and one for the top provided with lock and key, to prevent any accidents or interference. A cistern so built should last for ages, and keep the water pure, clear, cool, and free from vermin.

Not till the cement has properly hardened, say a day or two after the last coat has been applied, should the water connection with the spring be made and the arch commenced.

NUMBER OF BARRELS (31½ GALLONS) IN CISTERN.

Depth in feet.	Diameter in feet.								
	5	6	7	8	9	10	11	12	13
5	23	33	45	59	75	93	112	134	157
6	28	40	50	71	90	111	135	161	189
7	32	47	64	83	105	130	158	188	220
8	37	53	73	95	121	149	180	214	252
9	42	60	82	107	136	167	203	241	283
10	46	67	91	119	151	186	225	268	315
11	51	73	100	131	166	205	248	295	346
12	56	80	109	143	181	223	270	322	378
13	60	87	118	155	196	242	293	349	409

For cisterns that are tapering measure the diameter 4-10 from the large end.

HYDRAULIC RAMS.

The following useful information is given by a correspondent of the *Engineer:*

The efficiency of a ram need not be less than 60 per cent., and not as illustrating the highest efficiency obtained. One that I erected at Churchfield House, West Bromwich, gives off an efficiency of 84 per cent. I must acknowledge that I have not yet been able to reach 90 per cent. These are the proportions asked for by Mr. Hett:

(1) Fall, 18in.; supply, 19 quarts per minute; height of delivery, 20ft.; quantity raised, 1 quart per minute; length of injection pipe, 13ft, 6in.; diameter of pipe, 1¼in. at leading end and 1⅛in. at junction with ram, diameter of pulse valve, 2½in.; number of beats per minute. 68; efficiency of ram 70 per cent. (2) Fall 50ft.; supply, 16 quarts per minute; height of delivery, 153ft, ; quantity raised, 5 quarts per minute; length of injection pipe, 300ft., and 2in. diameter at leading end and ¼in. diam. at junction with ram; diameter of pulse valve, 2 in.; number of beats per minute, 120; efficiency of ram, 76 per cent. I believe that I am the only maker of hydraulic rams that uses a taper injectiou pipe, but its advantages must be obvious to any one who will give a moment's thought thereto.

"R. E D." has asked for, but not obtained, the proportions of a ram that will in his case yield an efficiency of 60 or 70 per cent. I herewith give him the particulars required. Height of fall being 9ft.; supply, 28 gallons per minute; height to be raised, 35ft.; and length of raising main, 250ft, Length of injection pipe should be 54 ft.; diameter at leading end, 4 in.: at junction with ram, 2½ in.; diameter of pulse valve, 4½ in.; number of beats about 75 or 80 per minute; diameter of raising main, 1½ in. With a ram otherwise well proportioned, an efficiency of at least 72 per cent may be relied upon, or a yield of 21 quarts per minute. I will guarantee 20 quarts.

The rule I adopted some years back for determining the proper size of a ram and the injection pipe, the quantity of water available as supply, and the fall being given; I may say in passing it is the result of a great number of experiments, and of close observation, and I have never known a ram yield less than 60 per cent since adopting it. Injection pipe at its junction with ram should be of the same diameter as a pipe which being one yard long and having a head of six inches, will pass three times the quantity of water that is available as supply, because the water in an injec

tion pipe only flows towards the ram about one-third of its time. Now, supposing we had a supply of 10 gallons per minute, a pipe one yard long, that will pass thirty gallons per minute with six inches of head, will require to be 1½ in. diameter, which is the size required. Having got the diameter of the small end, what size should the leading end be? Again, supposing we had a fall of 10 ft., a 1½ in. pipe, one yard long with 10ft., of head, will pass 134 gallons per minute, and it will require a pipe 2¾ in. diameter, one yard long with 6 inches of head, to pass 134 gallons per minute; the large end should thus be 2¾ in. diameter and taper down to 1½ in. at ram to be of equal carrying capacity throughout its whole length. Length should be 9 ft. long for each foot of fall. for 2 ft. and under. 8 ft. long for each foot of fall, for 3ft. and under ; 7ft. for each foot, for 4ft. and under; and 6ft. for each foot of fall, for 5ft. and upwards, with taper injection pipes.

"Area of pulse or impetus valve should be equal to four times the area of injection pipe, at its junction with ram, thus: Area of 1½ in. injection pipe being 1·7671, which, multiplied by four, gives 7·0684 as an area of valve, or 3in. diameter. No double valves are required where these proportions are used; the valve being of so large an area, its stroke never exceeds five-sixteenths, which entirely does away with the usual long sledge-hammer stroke that destroys the valve. Rising main should be of such a size that it will not add more pressure on the ram than is due to a head 2ft or 3ft. Of course the longer it is the larger it should be; a 1in. pipe 200 yards long will convey 2 gallons per minute with a little more than 2ft. 3in. of head; if it is 600 yards long it will require a head of nearly 10ft. to pass the same quantity."

STAFFORD, ENG., Feb. 1876. B. MASSEY.

Plate No. 1 shows an elevation of spring cistern, ram house, ram sentinel and pipes, and perspective view of farm house, barn, cistern and position of line of pipes, 36 inches below the surface, from ram to cistern, and the branches to house and barn. The walls of the spring and ram house are shown as of masonry or brick, but all the walls below 30 in. from surface may be made of cement, as in discription of cistern building, from that up should be of brick, or if obtainable flag stone on edge. The discription and cuts given in this work represents everything done in the most substantial and durable manner, for there is no experiment about it. and the cheapest way in the long run is to have it right at first, with every part made perfect the action of the ram is almost as certain as the spring itself.

Pipe should gradually enlarge from ram to spring, should be smoothe and straight to within a foot of the ram, at which point it should curve a little so as to fit the union at the ram level. The ends of all open pipes should be protected from vermin and obstructions by a brass gause wire, or a perforated pipe. The overflow pipe should have a T opening down, inserted just inside of the ram house, by which the overflow into the sentinel could be regulated, as sometimes when the spring is very flush, more water is furnished than the ram could use, and an outlet should be provided other than through the sentinel.

An overshot wheel 6 or 8 ft. diameter, made of galvanized iron, is sometimes used, a crank attached to the shaft which works a pump, giving in some cases very satisfactory results.

6ft. 9in. wheel (including frame and pump) costs from $125 to 150.
8 " 9 " " " " " 150 to 175

A double or diaphram ram is used in places where a small spring of good water issues near a brook. It is constructed similar to the ordinary ram, only having a large gasket of rubber between the ram and air vessel. The inlet from the spring is above the gasket as is also the discharge pipe.

As the water from the brook passes through the ram, its pulsations act on the gasket pressing it up, thereby driving the water in the discharge pipe up. It immediately falls back to place, creating a partial vaccuum which is filled at once from the inlet valve from the spring, the next stroke of the ram driving it out the discharge pipe. Such rams have been in use many years, and by simply replacing the gasket when worn out are just as easily handled as the ordinary ram and cost only $8.00 or $10.00 more.

DIFFICULTIES MET WITH IN THE USE OF HYDRAULIC RAM AND HOW OVERCOME.

When starting the ram after all the water has been left out of the discharge pipe, it requires the impetus valve pushed down repeatedly by hand till sufficient water has been driven up the discharge pipe to produce weight which causes the proper reaction in the drive pipe. If there is a sentinel attach- it will perform that duty.

Another difficulty is that the air chamber frequently fills with water, in that condition the ram is almost useless, and the noise communicated by each stroke along the line through the water for a hundred feet or more to the pipe in the house is very annoying. It occurs often by the iron air vessel being porus, (it seldom occurs in glass) which may be obviated by a coat or two of paint on the interior of the air vessel. If the air vessel is perfect and the sniff valve right it never occurs. Should a break occur in the discharge pipe, its locality may be found by stopping the ram for an hour or two, thereby allowing all the water above the break to leak out, then draw the water remaining in the discharge pipe, carefully measuring it, and by referring to the rule for capacity of pipes and measuring the distance from ram, the fracture may be found. The greatest difficulty in handling the ram is in the fact of the valve stopping up from sand or other impurities in

the water, or want of air in the air vessel, or from the failure of the spring to produce water enough for constant use.

These difficulties are entirely obviated by the sentinel.

THE PHILOSOPHY OF PUMPING.

Believing this article taken from Gould's catalogue, on the theory of pumps and pumping, is to the point we reproduce it.

"In the first place, the term suction pump, which is in so common use, is a misnomer, as there is no such thing as suction about a pump,

"If you will look at all pumps as *lift* or force pumps, a better understanding of their operation will be arrived at. What is called suction is simply this :

"Suppose a pump to be put into a well, with its cylinder say ten feet below the platform and twenty feet above the water. Now, the pressure of a column of air reaching from the surface of the earth upward to the extreme height of the atmosphere surrounding the air, weigh about fifteen pounds for each square inch of surface. A column of water, thirty to thirty-three feet high, (according to the condition of the atmosphere,) also weigh about fifteen pounds to each square inch of surface. When the pump is at rest, the pressure upon the inside and upon the outside of the suction pipe of the the water remains at an equal height, both inside and outside.

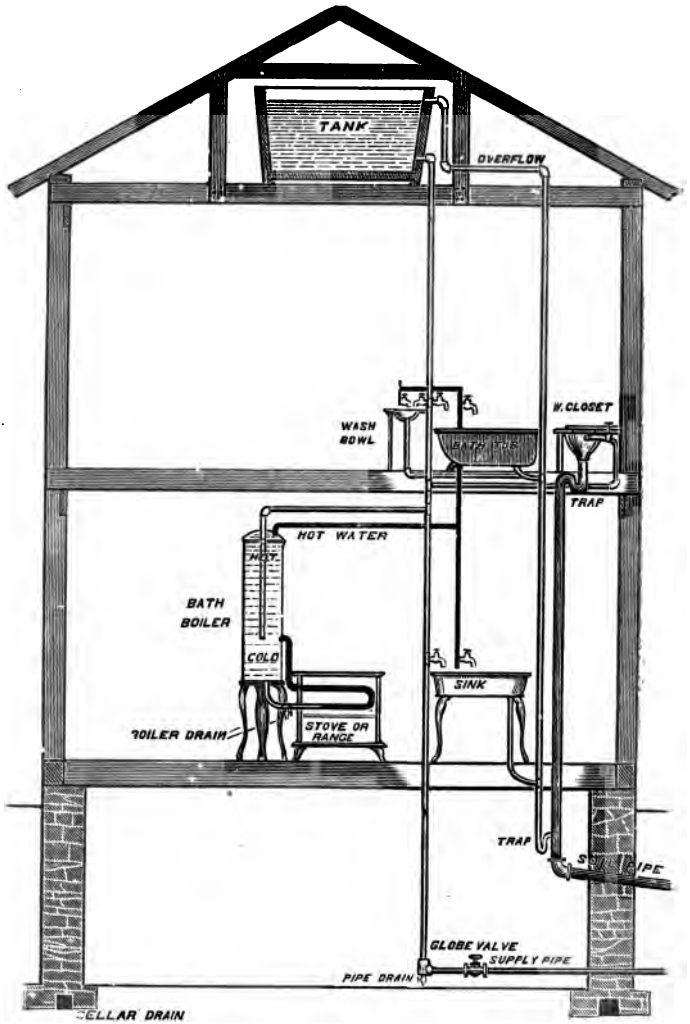
"Now grasp the pump lever, and set it in motion, and what is the result? At the first downward stroke of the pump piston, the valve in the piston opens and allows the piston to go down, while the air which was below passes through the valve, and finds a place above the piston. Reverse the motion, and move the plunger upward, and you lift the column of air above the piston as far as the piston itself moves upward, while the pressure of the atmosphere forces the water up in the pipe, to take the place of the air you have pumped out of the cylinder. The instant the plunger stops in its upward stroke, the lower valve closes, and thus prevents the air you have pumped out from going back into the pipe.

"Thus, at every stroke you lift out a certain portion of the air in the suction pipe, while at the same time the atmospheric pressure forces a corresponding quantity of water in to fill its place, and restore the equilibrium, which has been disturbed by a part of the pressure being removed. It is evident that in a short time all the air will be removed from the pipes, and replaced by water when he same process of pumping lifts the water to the surface, and discharges it from the spout.

"Now, to see why a pump will not draw water over thirty to thirty-three feet, suppose your pump cylinder to be forty feet from water, and commence the process of pumping as above. The result will be just the same. You will pump the air out of the pipe, and the atmospheric pressure will force the water in until the pressure inside and outside the pipe is equal. But it becomes equal when the water has reached that height at which the column of water weighs the same per square inch as the pressure of the atmosphere, and when you have arrived at that point, the water will lift no farther by atmospheric pressure, even though a perfect vacuum may be formed in the pipe above it. Therefore, if you wish to lift water farther than this distance, it becomes necessary to place the cylinder and working parts of the pump within that distance of the water.

"Theory says that the pressure of the air will raise water thirty to thirty-three feet, and a pump which will form a perfect vacuum will do so. But most people who expect perfection in this world are sadly disappointed; and a man who puts a pump thirty-three feet from the water, is apt to discover that pumps are not an exception to the rule; and a pump which was

PLATE 4.



Cut showing arrangement of Pipes, supplying Bath Room, in dwelling house, Bath Boilers and Rooms.

absolutely perfect would soon, by its own wear, become imperfect. Therefore we always advise putting the cylinder not over twenty-five feet from the water, and, where practicable, the nearer the water the better.

"A very common and very erroneous opinion is, that the height to which water is lifted by suction, (as is termed), is so much clear gain in the amount of power required. This is a mistake, as it takes just so much power to lift a certain amount of water to a certain distance, no matter how it may be done, or whether the piston of the pump be above or below the water.

"Another serious error into which people are apt to fall, is the idea that the size of pipes can be made too large for a pump. There is much danger that a pipe too small for the proper operation of the pump, may be used, but none whatever that it can be too large, even if it be as large as the pump itself, or even as "big as a barrel."

"The reason for this is simple, and easily understood. The pressure which a pump has to work against is the pressure per square inch due to the height to which you are raising water, (about one-half pound per vertical foot), multiplied by the number of square inches area of piston. Thus a cylinder of two-inch bore is 3.1416 square inches area, and this, multiplied by half as many pounds as you are raising water feet in height, will give the amount of weight to be raised by the piston through the means of power applied to a lever, or otherwise. This is entirely independent of the size of pipes, except that the pipes may be made too small, so that the friction of the water in passing through requires an additional amount of power to overcome it. A safe and always reliable rule is to use a pipe the inside diameter of which is one-half the inside diameter of the cylinder.

"This, of course, may be modified in many cases, but if purchasers will always put on pipes as large as the manufacturer recommends, there will be far less trouble with hard working pumps.

HOUSEHOLD HYDRAULIC.

Among the many inventions tending to lighten the labors of the household, and add inexpensive luxuries, none have been more prominent than in hydraulics. It was a rare occurrance, a few years since, for the rural kitchen to be supplied with water pipe, but as the great advantages and economy of such an arrangement was discovered, and appliances invented, making it feasible, knowledge in this department was eagerly sought; and many rural kitchens are now as well supplied with water as they of the cities, and the water is much superior as it does not contain any sewage taint.

As one of the most important considerations in introducing water pipes into a dwelling is to secure them from frost, the pipes should enter the cellar near the floor (at which point a drain cock should be inserted), and be conducted towards an inside partition or post, to remove it as far as possible from frost, being conducted up to the kitchen; and kept outside of partition in view, so that any leak could be readily discovered a T being inserted at proper height with which to connect with the sink; higher still a T with which to connect the bath boiler, the main pipe ascending to the second story and dis-

tributed to the bath room and closet. Unions should be inserted at various points so as to allow the pipe to be taken apart without taking the whole line down.

The bath boiler is a vessel made of cylindrical form, of wrought iron, 12 to 24 inches in diameter and from 3 to 8 feet high, capacity from 18 to 192 gallons, and capable of withstanding a pressure of 130 lbs. to the square inch. Its use is that of a hot water tank; and is of the greatest use in household economy as will be seen by plate 4, which represents bath boiler, together with stove or range. Water enters by main pipe, and passes through the boiler discharging the cold water near base of boiler By the action of heat in stove or range the water in circulation pipe is heated and has an upward tendency rises to upper end of boiler causing a current through bath boiler drawing the cold water from bottom of boiler, which in turn is heated and raised, and in a short time the water can be made quite hot and often is made to boil. The black pipes in plate 4 represents the hot water the light colored ones cold water. As hot water is drawn its place is supplied by cold water through the supply pipe . A drain cock should be inserted, by which all the water in bath boiler and pipes could be drawn out for repairs, or should the house be closed for a few days in winter, or during extreme cold weather if the house is not well heated, by placing one or two such safeguards when erecting water works much trouble and cost is avoided in the future.

PRICES OF BATH BOILERS.

Gallons.	Plain.	Galvanized.
18	$10 70	$14 05
24	12 50	15 75
28	14 85	19 80
52	23 25	30 60
100	42 00	54 00

THE BATH ROOM.

Is an indispensable adjunct to the well appointed dwelling and in planning a central and easily accessible spot should always be reserved for it. It should be well ventilated and as nearly over the range as possible so as to have but a short line of pipe between it and the bath boiler. It need not be large, many do not exceed 7x10 feet, though where possible they should not be less than 8 or 10x12. It should contain a stove, for heat is absolutely needed and withal is very pleasant. Bath tubs are made of various materials, but iron is

probably the best and most satisfactory material. It should be well painted internally as well as externally. The most objectionable feature is that it being heavy requires more hot water to overcome the cold of the metal than where sheet metal is used. Those made of wood lined with sheet zinc, or copper, are considered most nobby. They are objectionable only as being of light material are more readily injured.

Care should be taken to have traps inserted in sewer or waste water pipes. A shower bath connected with both hot and cold water pipes is an inexpensive, luxurious addition to the bath room and with the addition of washbowl completes the bath apparatus. A trap is formed by having the pipe U shaped, so as always to retain some water to prevent gas rising.

The water closet is a modern invention at least in its present perfect condition and is indispensable expecially in sickness. They are so simply and perfectly constructed now that their presence in the room is not noticed.

PIPES.

The Ancients constructed pipes of stone, cement, wood and to a very limited extent, of metals. Lead pipes were formerly made only in short length, but can now be made of almost any desired length.

The objections made to lead pipe are that it is costly, is easily dinted or closed by a stroke; a novice is unable to unite the joints properly; it is liable to decay in spots from the action of chemicals in the earth, but the most serious objection, which, in many cases is certainly unfounded, is that chemical action taking place in the water taints it, causing lead-poisoning.

An improved pipe stronger than lead pipe and communicating to the water no deleterious properties is a lead pipe lined with tin. It has a very smooth and perfect internal surface.

Pipes are made of both cast and wrought iron. The former in short lengths and seldom of small calibre. The objections to cast iron pipes are mainly in cost. Cast iron is usually employed where large pipes are required.

Wrought iron, or as it is most frequently called gas-pipe, is coming into almost universal favor of late, from the many good points it possesses. It is manufactured from bar iron, which being heated to a welding point as it is drawn from the furnace passes through a machine forming it into a tube, and welding the edges together. Wrought iron has more affinity for oxygen than cast iron, making it less durable. A superior pipe, and one used extensively, is made by coating

the gas pipe with zinc, thereby protecting it from the action of the air or chemical which would soon destroy the plain iron pipe. Some persons think it, like lead, imparts to the water poisonous qualities, but in the use of it for years we find no such objection.

A pipe having the highest claims as to strength, cost, surface, and freedom from poisonous effects, is the enameled pipe it being coated both internally and externally with a black enamel which is baked or fused on. The good points of gas pipe are in the fact of it being cheap, readily joined together, requiring but little skill, not readily bruised, and capacity to withstand heavy pressure.

Wooden pipes from their early decay, and the bad taste they imparts to the water, are but little used, except as pump logs, and they of a peculiar wood; durable and free from taste. The are made of timber 4 or 5 in. square, 10 or 12 feet long and after the hole is bored, reamed out at one end, and hooped with iron, tapered at the other end to fit the large end of the next pipe.

Earthen pipes called Terra-Cotta are made of stiff clay, vitrified and burned similar to brick, when properly made and burned are imperishable. They are made in lengths of about two feet, and from 1 in. diameter up to 2 or 3 feet, or more. They are principally used as sewer and drain pipes, and are jointed with cement and require great care to secure perfect joints, and at best are incapable of withstanding much presure.

TERRA COTTA PIPE COSTS

2 inch 13c. per foot, 3 in. 16c. 4 in. 20c. 5 in. 25c. 6 in. 30c. 10 in. 70c.

A more common kind of clay pipe is made for drainage from ordinary brick clay. The ends of the pipe are simply laid together, and kept in place by a loose fitting collar, the object being to admit water from the soil freely.

SEWAGE.

The Closet is now indispensible in all well-furnished houses, either in country or city. Earth Closets certainly should claim the preference, for when properly understood and well managed, are preferable to water, especially where fertilizers are an object. But where an abundant supply of water is to be had, many would prefer its use as it is perhaps less trouble. There is quite a variety of good closets, each having its peculiar advantage over the other. The Philadelphia and the Jennings rank high. The latter being made almost entirely of earthenware, and the valves and traps seem so constructed

as to be readily reached. The soil pipes should be of good size; the vertical pipes not less than 3 inches, and those horizontal much larger. The horizontal pipe should pierce the cellar wall below frost line and have a fall from that point to the sewer, or if there is no sewer to the top of a cistern from 20 to 100 feet from the house. The cistern may be built of rubble stone, and left so the fluid may gradually sink away, or it may be cemented and the contents removed, when necessary. It should be arched in a substantial manner, and an opening left through which to remove contents. The end of the soil pipe should enter the cistern near the top to admit of a free flow, and after all is completed, cover the cistern entirely with earth to prevent the escape of offensive gasses.

VITRIFIED DRAIN PIPE.

Size,	2 in.	3 in.	4 in.	5 in.	6 in.
Price per foot,	13	16	20	25	30. cts.

Earthenware water closet basin, from $ 2 20 to 8 75.
Water closets, Philadelphia pattern, 11 00 to 12 00.
" " Jennings pattern, ------ ------
Earthenware white basins, from $1 75 to $3 25.

Size,	2 in.	3 in.	4 in.	6. in.
Cast iron traps for soil pipe,	$1 95	$2 25	$3 25	$5 25.

Cast iron bath tubs,	length.	depth.	width.	price.
	No. 1—66 in.	18½	25½	$21 00
	No. 2—72 in.	18½	25½	23 00

Fine brass wire guage, No. —, costs —— per square foot.

Filters are indispensible in many cases, as water is frequently so impregnated with impurities, animalcule, &c., that its use without filtration is unsafe, as well as unpalatable. Rain water, after standing for some time, especially in the summer months, and if the cistern is not perfectly constructed, becomes alive with animalcules, and is also impregnate with filth washed from the roofs, and may also be tainted from sewage, all of which may be removed if a proper filter is used. Filters are constructed on the principle of a sieve, a series being used, removing the obnoxious matter mechanically in part, to which is added chemical action to remove offensive taints as well. Sponge asbestos, sand, charcoal, and many other substances are used. Sponge, from its tendency to decay rapidly does not make a permanent filter. It is very effective to gather the coarser particles, but should be often removed and cleansed. Cisterns are often constructed with a porous brick wall as a division, the water entering at one side and percolating through the brick, leaves its impurities. In time it becomes clogged up and looses its virtues. In addition to the wall as a division between the crude and the filtered water, a filter is made by leaving out one brick in the lower

part of the wall and placing a layer of course gravel on the floor, reaching above the hole left in the division wall, on which a layer of finer gravel is placed, then broken charcoal and sand alternating, with layers of each till sufficient to make a perfect filter has been made. If in the construction of cisterns and wells proper care is exercised there is seldom need of a filter.

	½ in.	¾ in.	1 in.	2 in.
Strong lead pipe weighs, per foot,	1 lb. 12 oz.	3 lb.	4 lb.	8 lb.
Price, per pound, about 12 cts.	——	——	——	——

Bibbs and cocks cost from $3 00 to $4 00 each.

PRICE EACH FOR FITTINGS FOR GAS PIPE.

Size,	½	¾	1	1¼	1½	2	inches.
Elbows,	8	11	16	20	30	45	cts.
T,	11	15	20	30	45	65	"
Couplings,	06	08	10	15	20	35	"

WROUGHT IRON WELDED TUBES.

SIZE INSIDE DIAMETER.	PRICE PER FOOT BLACK.	PRICE PER FOOT GALVANIZED.	PRICE PER FOOT ENAMELED.
⅛ inch.	6 cts.		
¼ "	6 "	11 cts.	11 cts.
⅜ "	7 "	12 "	12 "
½ "	7 "	12 "	12 "
¾ "	9 "	16 "	16 "
1 "	12½ "	22 "	22 "
1¼ "	18 "	30 "	30 "
1½ "	22 "	34 "	34 "
2 "	31 "	45 "	45 "
2½ "	46 "	70 "	70 "
3 "	60 "	90 "	90 "
3½ "	80 "	1.20 "	1.20 "
4 "	1.00 "	1.50 "	1.50 "
4½ "	1.25 "	1.80 "	1.80 "
5 "	1.50 "	2.20 "	2.20 "
6 "	2.00 "	3.25 "	3.25 "
7 "	2.85 "		
8 "	3.50 "		
9 "			
10 "			
12 "			

LIQUID MEASURE.

4 gills make one pint.
2 pints make 1 quart.
4 quarts make one gallon.
31½ gallons make one barrel.

CAPACITY OF PIPE.

28	feet	of	½	in.	pipe	will	hold	1	quart.
18	"	"	⅝	"	"	"	"	1	"
12	"	"	¾	"	"	"	"	1	"
7	"	"	1	"	"	"	"	1	"
4 feet 6 in.		"	1¼	"	"	"	"	1	"
3 " 1 "		"	1½	"	"	"	"	1	"
1 " 9 "		"	2	"	"	"	"	1	"

CEMENT.

Hydraulic Cement or water lime, so called from the power it posesses, of hardening under water. is a most important element in Hydraulic engineering, and a knowledge of its properties, and how to apply it, is of prime importance. It was known to the Ancients, though but little of the history of its discovery can be traced. We find it in the aqueducts of Rome—the work constructed with it is as imperishable as the stone itself, and has given to the best cement of by-gone years the name of Roman Cement, consist of a chalky deposit, and is found in many parts of the world of different characteristics and powers. The most powerful cement in use is the Portland, made from the chalk deposits of the rivers Thames and Medway, of England.

" To England is due the credit of having first introduced the manufacture of Portland Cement on a large scale ; and although other countries, especially France and Germany, have introduced its manufacture in certain limited locaļities, the peculiarly advantageous position of England in having inexhaustible stores of the raw materials, in their cheapest and simplest conditions, coupled with the low price of fuel, enables that country to supply the article to every quarter of the globe.

" Portland Cement is now ehemically described as a double silicate of Lime and Alumnia, and posesses, in an eminent degree, the well-knownn property of hydraulicity, or capa of setting and hardening under water. Indeed, it may familiarly be described as an rtificial improvement on the best hydraulic limes with the additional excellent property of continuing good for a longperiod in any climate. Its manufacture was introduced about forty-four years ago, by ASPCIN, but until within the last fifteen years the quantity made was comparatively limited, and might have probably continued so, but for the intelligent appreciation of its merits by foreign engineers and architects.

"Portland Cement is made from the deposits of chalh on the shores of the Rivers Thames and Medway, mixed with alluvial clays from the estuaries and creeks; the simple nature of these ingredients render the manufacture of the cements a comparatively easy operation, unless where gross carelessness permit an irregular mechanical admixture or manipulation of the several constituents.

Portland Cement should weigh not less than 106 lbs. to the struck imperial bushel, loosely measured.

MIXING.

The Cement should be mixed to the consistence of mortar, with the requisite amount of sand or gravel added. For first-class work, use one part Cement to three parts sand or gravel; for ordinary work, such as concrete floors for barns, &c., use eight parts sand or gravel to one part Cement; this makes an excellent concrete, and soon sets to a granite-like hardness; before applying the Cement or concrete, wet the parts to which it is to be applied, and use immediately, as the Cement, once mixed, cannot be used again after having set.

FOR FLOORING AND PAVING.

The ground should be well rammed and leveled with broken bricks or stone to within three inches of the intended line of flooring, and with a mixture of one part Cement to from three to eight of sand, as the nature of the work may require; the paving should be filled up to the required thickness, and finished either with a steel or wooden float, and left to harden for forty-eight hours.

For floors, where a fine, hard, enameled surface is required, the work should be floated with a steel float or trowel, but for out-door paving the wooden float is better adapted for the purpose.

FOR HYDRAULIC WORKS.

In the construction of reservois, tanks, fish-ponds, etc., required to be water and vermin-tight, the brick-work should be set in a mixture of one part Cement and one part sand, and stuccoed internally with pure Cement, from half to three-quarters of an inch in thickness, or the composition of Cement one part and sand three parts may be used, if water is not immediately let into the work.

No. 1.

One barrel of Portland Cement mixed with 16 gallons of water is equal to $1\frac{1}{6}$-100 barrels of Cement paste, and should cover 100 square feet of surface, ($\frac{1}{2}$) one-half inch thick.

No. 2.

One barrel of Portland Cement and *two* barrels of clean sharp sand mixed with $23\frac{1}{2}$ gallons of water is equal to $2\frac{1}{2}$-barrels of mortar, and should cover 219 square feet of surface one-half inch ($\frac{1}{2}$) thick.

No. 3.

One Barrel of Portland Cement and *three* barrels of clean sharp sand mixed with 28½ gallons of water is equal to 3⅓ barrels of mortar, and should cover 285 square feet of surface one-half inch (½) thick.

PRICE OF CEMENT.

Louisville,	$2 00 per bbl.	Weight,	275 lbs.
Youghiogheny,	2 00 " "	"	300 "
Rosendale,	2 00 " "	"	310 "
Portland,	5 50 " "	"	400 "

A DESCRIPTION OF THE WATER-WORKS ON THE FARM OF THE WRITER

At Hulton, Pa., a suburb of Pittsburgh, might be of service to those wishing to erect similar works. The spring averages four gallons per minute. There are two rams in use, the upper one, No. 3, having a one inch drive pipe 45 feet long, with a fall of 4 feet. The waste water from the upper ram flows into a barrel on end, which is used as a spring cistern for the lower ram. The drive pipe for lower ram runs from the middle of the barrel, and the overflow from near the top of it. The lower drive pipe is fifty feet long, 1¼ in diameter, and has a fall of 15 feet. The discharge pipe, galvanized gas pipe, is laid from the lower ram, connecting with the discharge from the upper ram to a point 1,100 feet distant, and to an elevation of 80 feet. Four hundred feet of the lower end of the line is of ¾ pipe, the middle 300 feet of 1 inch, and the balance of the line 1¼ inch, and answers both for a discharge from the ram and supply from the cistern. The discharge pipe enters the cistern near the bottom of it, thereby enabling us to draw all the water from the cistern at any point along the line. At various points along the line, branches were taken off to supply the three houses using the water. A lavish use is made of it by all in kitchen and bath-room, and with hose for carriage cleaning, and withal, in one weeks time, it gathers a store of 100 barrels. It was a constant care to keep the ram running till the sentinel was applied, since which time it has worked with but little attention. One of the rams had been in constant use 6 years before needing a new impetus valve and seat, which cost $3 00, and now seems as good as ever.

THE OLD OAKEN BUCKET WHICH HUNG IN THE WELL.

How dear to this heart are the scenes of my childhood,
When fond recollection recalls them to view—
The orchard, the meadow, the deep-tangled wildwood,
And every loved spot which my infancy knew;
The wide-spreading pond, and the mill which stood by it,
The bridge, and the rock where the cataract fell,
The cot of my father, the dairy house nigh it,
The old oaken bucket—the iron-bound bucket—
The moss-covered bucket, which hung in the well.

The moss-covered vessel I hail as a treasure.
For often, at noon, when return'd from the field,
I found it the source of an exquisite pleasure,
The purest and sweetest that nature can yield;
How ardent I seized it, with hands that were glowing,
And quick to the white-pebbled bottom it fell,
Then soon, with the emblem of truth over-flowing,
And dripping with coolness, it rose from the well—
The old oaken bucket—the iron bound bucket—
The moss-covered bucket arose from the well.

How sweet from the green mossy brim to receive it,
As poised on the cord, it inclined to my lips;
Not a full-blushing goblet could tempt me to leave it,
Though filled with the nectar that Jupiter sips,
And now far removed from the loved situation,
The tear of regret will intrusively swell,
As fancy revisits my father's plantation,
And sighs for the bucket which hangs in his well—
The old oaken bucket—the iron-bound bucket—
The moss-covered bucket which hangs in his well.

The Dexter Spring Company is located at Hulton, Allegheny county, Pa., 12 miles north of Pittsburgh.

They manufacture the CELEBRATED DEXTER SPRING and the GRIER HYDRAULIC RAM and SENTINEL.

The Dexter is a double side-spring.

By its peculiar structure, the following points are secured, embracing strength, durability, elacticity, economy and comfort:

The springs make the connection between front and rear axle, thereby dispensing with the cost and avoiding the rigidity of a perch or reach. They form really an elastic reach, a point of vital interest when considering comfort, cost and durability.

The springs being long and exceedingly elastic and placed in the line of motion of the vehicle, together with the Dexter fifth wheel, allows of such free tortional motion that the vehicle built with these springs is unquestionably the most comfortable known, as it is also the most durable.

Of the hundreds now in use not a single broken spring of our make has been reported. Only one grade of steel, the best cast steel of spring temper, made to our special order, is used. It is capable of great service, and is remarkable for its elasticity and strength.

One of our ordinary three passenger springs, taken at random from a pile of 30 set, was subjected to a test of over 2,000 pounds, for many hours, resuming its original position as soon as the load was removed.

The Dexter Spring Company also manufacture the improved Hydraulic Ram and Sentinel, as described in this work.

They also make estimates for the cost of Rural Hydraulic improvements.

Bids will be made for the material, pipes, ram sentinel, tank, cement, tools, etc., delivered at the nearest railroad station, or at Pittsburgh, as the parties may prefer.

Persons wishing to make such improvements should send a sketch describing the lay of the land, for a distance of 50 to 100 feet below the spring and from the spring to the house or cistern, and the distance between points and height and grade of each as near as may be. The quantity of water furnished by spring per minute and the size of cisterns desired and the kind of pipe preferred.

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Rural hydraulics :
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